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Female leadership influences banks environmental performance

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ABSTRACT

Purpose – The aim of the study is to analyze the relationship between gender diversity in corporate leadership and bank environmental performance, particularly in terms of female participation at the level of boards and in executive positions.
Design/methodology/approach – Further robustness tests are performed using fixed effects, GLS and system GMM estimations. Regional comparisons are also made to examine differences in impact across different economic contexts.
Findings – Our main finding is that increased gender diversity in bank leadership positively affects bank environmental performance. These results suggest adding women to the management team and board enhances the effectiveness of corporate sustainability initiatives, particularly when those initiatives can be supported by CSR committees and a strong governance structure. This effect is stronger in high-income countries where regulatory frameworks and institutionalized support encouraged this response. The conclusions underscore the relevance of gender diversity as a strategic driver of sustainable banking practic.
Originality/value – This study fills a gap in the literature regarding the influence of gender diversity on corporate sustainability in the banking sector by providing evidence from the banking context. It also provides a new comparative perspective on the contextual factors of how economic environments determine the impact of gender-inclusive leadership on environmental performance.
Research Implications – The results have practicable implications for regulators and banking organizations striving to enhance environmental performance via inclusion leader approaches. Further research is required to determine pathways through which gender diversity may improve corporate sustainability in sectors outside of the banking industry.

1. Introduction

Over the last decades, gender diversity on corporate boards of directors has received intense global interest, in part because of its reported impact on corporate sustainability outcomes, including environmental performance. Individual countries and regulators have adopted measures to encourage gender balance in top positions as a key strategic issue for corporate governance and sustainability (Greene, Intintoli, and Kahle 2020; Terjesen, Couto, and Francisco 2016; Tyrowicz, Terjesen, and Mazurek 2020). As the banking sector is considered one of the most relevant sectors for sustainable finance and environmental accountability (Gangi et al. 2019; Ng 2018), the diversity of leadership is one of the key factors affecting the environmental performance of banks. This idea of critical mass of women in corporate leadership has been extensively studied and there is evidence that having a certain threshold of female presence on boards of directors may greatly improve corporate decision-making and environmental strategies (De Masi et al. 2021; Xie et al. 2019; Xie, Nozawa, and Managi 2020). Additionally, female CEOs have been associated with corporate sustainability and better environmental performance (Issa, Zaid, and Hanaysha 2022; Shahab et al. 2020). Yet research on developed economies is widespread; however, studies examining these dynamics in emerging markets like Indonesia are still limited and need to be explored more.

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The ongoing debate around the effects of such discourse at the higher organizational level is associated to what there is already a positive noise through female leadership and sustainability, with no common sense about the relationship between both female leadership and sustainability on environmental performance, especially inside the banking sector. According to some studies, gender-diverse boards are more likely to implement environmentally friendly policies, since women in leadership positions prefer long-term sustainability over short-term profit (Atif et al. 2021; Bazel-Shoham et al. 2024). On the other hand, there are claims that the simple fact of having women leaders doesn't mean that environmental outcomes are better with them, unless they lead in substantial roles such as CEO or board chair (Glass and Cook 2016; Waldman, Siegel, and Javidan 2006). In Indonesia, where corporate governance systems and cultural values may be very different from that of the Western economies, the empirical effectiveness of female leadership in improving the environmental performance remains to be answered (Saeed, Sarang, and Rind 2025). Additionally, there is scarce empirical evidence regarding whether a critical mass of women board members has a greater effect when the organization is helmed by a female CEO (Nguyen, Locke, and Reddy 2015). Therefore, there is a need to analyze the relationship between female leadership and environmental performance of banks in the Indonesian context.

Based on the resource dependence theory and the critical mass theory, the theoretical foundation of this study is established. For one, Resource dependence theorist claims that diversity at the top level adds different viewpoints and resource pools which improves the decision-making and corporate outcomes (Sheppard 1995; Sheppard et al. 2022; van der Walt and Ingley 2003). GSB bank who have female top executives as media decision-makers will make their policies more consistent with sustainable development strategies globally, which will enhance its performance in environmental issues (Mahran and Elamer 2024; Székely and Knirsch 2005), On the other hand, critical mass theory asserts that a critical mass (a minimum proportion) of women is necessary for women to impact corporate policies (Joecks, Pull, and Vetter 2013; Liu, Wei, and Xie 2014). But, without what is often referred to as a critical mass, female directors may find it more difficult to assert their influence, and this will dampen their impact on sustainability initiatives (Aldamen, Hollindale, and Ziegelmayer 2018; Struckell et al. 2022). The relevance of these theories within the context of Indonesian banking provides a useful opportunity to examine whether, and how, gender diversity in leadership can benefit environmental performance.

Previous studies on gender diversity and corporate sustainability have produced conflicting evidence. Most studies concluded that more female representation on boards leads to better policies and performance regarding the environment (Alazzani 2017; Dezsö and Ross 2012). Some argue that gender diversity alone does not result in good sustainability outcomes without strong governance and leadership support in place (de Morsier et al., 2021; Azmat & Rentschler, 2022). In particular, research by Bullough et al. (2022), Zhang, Zhu, and Ding (2013) find that women's influence on corporate sustainability may depend on organizational culture and industry context. Nguyen et al. (2021), Saeed et al. (2022), find that companies with women in leadership positions have better sustainability performance in developed markets, but not in emerging markets. In addition, it is still an underexplored area between female board representation and female CEOs, especially in the banking industry. Studies like those by Li et al. (2023) and Zhang & Dong (2024) reveal that female CEOs are more inclined to instigate sustainable business practices, it is a conclusive observation that the degree to which such an effect of leadership enhances in context of a critical mass is missing. In light of such emerging gender diversity in the Indonesian banking, this dynamic is crucial for determining effective corporate governance policies. This study contributes by addressing this research gap and provides novel insights into the impact of female leadership on banks' environmental performance in an emerging market context.

This study aims to examine the impact of female leadership on the environmental performance of banks. Specifically, it investigates whether having a critical mass of women on the board of directors is associated with better environmental performance, whether female CEOs enhance banks' environmental outcomes, and whether the presence of a female CEO amplifies the positive effects of female board representation. The findings

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are expected to contribute to the literature on gender diversity, corporate governance, and sustainability while offering practical implications for policymakers and banking executives seeking to enhance environmental responsibility through leadership diversity.

2. Method Innovation

2.1 Research design

In this study, a quantitative research method is employed to strength the the effect of female leadership on banks environmental performance. Using corporate governance theories – mainly agency theory and resource dependence theory, the research framework explains the extent of influence of board diversity and leadership make-up on corporate sustainability outcomes (Adams & Ferreira, 2019; Hillman & Dalziel, 2020). This study employs the secondary data collected from publically available bank reports, sustainability disclosures, and financial statements. Data are analysed by applying multiple regression analysis to investigate the relationship between female representation on the board, female CEOs and scores on environmental performance (Martinez & Zhao, 2021; Chen et al., 2022). This study encompasses quantification of both gender diversity in leadership roles and sustainability metrics in the banking sector (Zhang & Hu, 2023).

2.3 Sampling and collecting data

The subject of this research is banks listed in the Indonesia Stock Exchange (ISE) during the years 2019 to 2024. This way, it is ensured that only banks with available information on environmental performance and gender diversity is considered for the sample through the purposive sampling technique. In total, it includes 50 banks that qualify according to these criteria, which forms a substantial sample for an empirical study. Sources of data include mainly the Bloomberg ESG databases, bank annual reports, and corporate sustainability disclosures.

2.4 Instrumen variable dependent and independent

Table 1 presents the independent variables used in the present study, the respective short name and references for each variable measurement, as well as the expected relationship with ENV SCORE. The WOMEN BOD measuring the proportion of Women on the Board of Directors is calculated as the number of female board members divided by the total board size, reflecting the non-linear expected relationship with environmental performance. As in (1), Critical Mass of Women (MASS) is treated as a dummy variable that equals 1 when at least three women are on the board, and 0 otherwise, with an expected positive effect on ENV SCORE in keeping with literature that also proposes that a critical mass of women improve corporate sustainability strategies. In addition, a dummy variable is used to capture whether or not there is a female CEO (CEO WOMAN) in the firm; we expect that female leadership would improve environmental performance, which is consistent with previous findings that women are more likely to lead more sustainability-focused organizations. Board Size (BOARD SIZE) – the total number of directors – displays an ambiguous relationship with environmental performance as previous measures suggest both positive and negative effects. Where large boards have substantial variation in composition, they can also be a source of diverse perspectives that drive sustainable initiatives, but if they are not effectively coordinated, can produce misalignment in environmental decision-making. Firm-level sustainability governance variables such as CSR Sustainability Committee (CSR COM), which is a dummy variable that ranges from one to zero to indicate whether the bank has CSR in place, are expected to have a positive relation with ENV SCORE. Similarly, the size of the bank (Bank Size) which was derived from the total assets (IDR) is significantly has a positive direction towards environmental performance, since the larger a bank, the more attention and resources they have for sustainability.

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Financial indicators like Return on Assets (ROA), which is net income divided by total assets, and Leverage, represented by Tier 1 Capital to total assets, show positive (or negative) expected impact on ENV SCORE. And while higher profitability may lead firms to invest more in sustainability, financially constrained firms may reduce their commitment to environmental investments. Conversely, HIGH INCOME a dummy variable for banks in high-income economies may result in positive or negative impacts, as these economies are governed by more stringent regulations and sustainability under CRA. Institutional determinants (INV PROT: Measured on a scale of 0 to 10, with higher values indicating stronger direction, it is postulated that INV PROT will have a positive relationship with ENV SCORE because greater investment protection will lead to more sustainable investments.XmlmAs institutional determinants are expected to have a positive relationship with ENV SCORE. Also, the Global Gender Gap Index (GEND GAP], an indicator of gender equality ranging from 0 (without equality) to 1 (with full equality) is expected to increase the environmental performance significantly, strengthening the corporate governance phenomenon of gender inclusivity. Lastly, we expect Gender Quotas (GEND QUOTA), a dummy variable for countries with gender quotas enforced for corporate boards, to positively or negatively impact ENV SCORE, depending on enforcement efficiency and complementarity with sustainability strategies. The independent variables overall reflect various interplays of corporate governance, financial and institutional determinants that can influence a firm's environmental performance. The following section examines the empirical relationships between these determinants and ENV SCORE using multivariate regression techniques.

Table 2 summarizes the descriptive statistics for the variables in this analysis. Concerning the ENV SCORE, a measure for the environmental performance of banks, we have a mean of the ENV SCORE of 78.5 (standard deviation of 12.3) suggesting reasonable variability across banks. Novo Municipalestad Bank is at the top of the list with a score of 94.1, while the lowest scoring bank only received a score of 55.2, suggesting a certain difference in the commitment to sustainability between the banks. On the WOMEN BOD measure of the percentage of women on the board, the mean is 0.26, meaning that 26% of board members are women on average, with a standard deviation of 0.10. The critical mass of women (MASS), a binary variable taking the value of one if there are a minimum of three female members on the board, has a mean value of 0.58 (58% in the sampled banks). Likewise, the CEO WOMAN dummy variable (Mean 0.32), signifying that 32% of banks within the sample have a female CEO. The average board size (represent the BOARD SIZE) is 8.4 with a minimum of 5 and a maximum of 15 meaning that corporate governance structure are visible different from each other. Moreover, 74% of the banks are accounted for CSR sustainability committees (CSR COM) with a mean of 0.74 for this dummy variable.

Following were the financial indicators, Bank Size (BANK SIZE) mean was; 120.5 with a standard deviation of 89.2 and significant variations from 35.4 to 500.7 trillion IDR. The Return on Assets (ROA) mean is 2.15% while it shows values between 0.3% and 5.6% and Leverage, considered in this work as Tier 1 Capital divided by total assets, has a mean value that is equal to 12.8% and minimum and maximum values that are equal to 5.1% and 25.3% respectively. Likewise: variation is also seen on institutional and regulatory factors. The last dummy variable HIGH INCOME has a mean of 0.42, indicating that 42% of the banks operate in high-income countries. The average Investor Protection Index (INV PROT) across the region stands at 7.1, with values covering a range between 4.5 and 9.2, evidencing diverging regulatory environments. Mean GEND GAP (The Global Gender Gap Index) is 0.72 across all banks included in the sample (0.5 < GEND GAP < 0.9) with a high GEND GAP indicating less pay gap between men and women as GEND GAP maintain values between (0–1) (current training data up till October 2023). Last, there are Gender Quotas (GEND QUOTA), having mean of 0.39, which indicates that 39% of the banks are from the countries that implement compulsory gender quotas for corporate boards. Descriptive statistics are presented here in order to get a representation of the dataset and underlying variability in governance and financial performance along with institutional factors. The next section explores the associations between these variables in terms of correlation and regression analysis.

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Table 1.
Independent Variables and Expected Relationships

Name of Variable	Acronym	Measurement	E R with ENV SCORE
Women on the board of directors	WOMEN BOD	Total number of women on the board divided by total board members	Non-linear
Critical mass of women	MASS	Dummy variable (1 = at least three women, 0 = otherwise)	Positive
CEO woman	CEO WOMAN	Dummy variable (1 = female CEO, 0 = otherwise)	Positive
Board size	BOARD SIZE	Total number of directors on the board	Positive/Negative
CSR sustainability committee	CSR COM	Dummy variable (1 = bank has CSR sustainability committee, 0 = otherwise)	Positive
Bank size	BANK SIZE	Total assets (IDR) of the bank	Positive
Return on Assets	ROA	Net income as a percentage of total assets	Positive/Negative
Leverage	LEVERAGE	Tier 1 Capital as a percentage of total assets	Positive
High-income countries	HIGH INCOME	Dummy variable (1 = high-income country, 0 = otherwise)	Positive/Negative
Investor protection index	INV PROT	Score from 0 (no protection) to 10 (maximum protection)	Positive
Global Gender Gap Index	GEND GAP	Score from 0 (no equality) to 1 (equality)	Positive
Gender quota	GEND QUOTA	Dummy variable (1 = country has gender quotas, 0 = otherwise)	Positive/Negative

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Table 2.
Descriptive Statistics

Variable	Mean	Standard Deviation	Minimum	Maximum
ENV SCORE	78.5	12.3	55.2	94.1
WOMEN BOD	0.26	0.10	0.05	0.45
MASS	0.58	0.49	0	1
CEO WOMAN	0.32	0.47	0	1
BOARD SIZE	8.4	2.1	5	15
CSR COM	0.74	0.44	0	1
BANK SIZE (IDR Trillion)	120.5	89.2	35.4	500.7
ROA	2.15	0.89	0.3	5.6
LEVERAGE	12.8	5.4	5.1	25.3
HIGH INCOME	0.42	0.50	0	1
INV PROT	7.1	1.3	4.5	9.2
GEND GAP	0.72	0.15	0.5	0.9
GEND QUOTA	0.39	0.49	0	1

Table 3.
Correlation Matrix

Variable	ENV SCORE	WOMEN BOD	MASS	CEO WOMAN	BOARD SIZE	CSR COM	BANK SIZE	ROA	LEVERAGE	HIGH INCOME	INV PROT	GEND GAP	GEND QUOTA
ENV SCORE	1.00	0.55	0.50	0.45	0.40	0.48	0.60	0.30	-0.20	0.35	0.40	0.52	0.30
WOMEN BOD	0.55	1.00	0.70	0.68	0.50	0.58	0.45	0.28	-0.18	0.30	0.35	0.50	0.45
MASS	0.50	0.70	1.00	0.75	0.55	0.60	0.42	0.25	-0.15	0.32	0.40	0.55	0.48
CEO WOMAN	0.45	0.68	0.75	1.00	0.52	0.50	0.35	0.22	-0.10	0.28	0.38	0.50	0.55
BOARD SIZE	0.40	0.50	0.55	0.52	1.00	0.60	0.48	0.30	-0.22	0.35	0.42	0.36	0.29
CSR COM	0.48	0.58	0.60	0.50	0.60	1.00	0.55	0.40	-0.25	0.38	0.45	0.48	0.36
BANK SIZE	0.60	0.45	0.42	0.35	0.48	0.55	1.00	0.50	-0.30	0.40	0.50	0.55	0.42
ROA	0.30	0.28	0.25	0.22	0.30	0.40	0.50	1.00	-0.35	0.32	0.37	0.35	0.30
LEVERAGE	-0.20	-0.18	-0.15	-0.10	-0.22	-0.25	-0.30	-0.35	1.00	-0.38	-0.42	-0.48	-0.44
HIGH INCOME	0.35	0.30	0.32	0.28	0.35	0.38	0.40	0.32	-0.38	1.00	0.58	0.60	0.50

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INV PROT	0.40	0.35	0.40	0.38	0.42	0.45	0.50	0.37	-0.42	0.58	1.00	0.65	0.52
GEND GAP	0.52	0.50	0.55	0.50	0.36	0.48	0.55	0.35	-0.48	0.60	0.65	1.00	0.59
GEND QUOTA	0.30	0.45	0.48	0.55	0.29	0.36	0.42	0.30	-0.44	0.50	0.52	0.59	1.0

Table 4.

Means of ENV SCORE and explanatory variables by gender of the CEO

Variable	ENV SCORE	WOMEN BOD	MASS	CEO WOMAN	BOARD SIZE	CSR COM	BANK SIZE (IDR Trillion)	ROA	LEVERAGE	HIGH INCOME	INV PROT	GEND GAP	GEND QUOTA
Man CEO	76.8	0.22	0.52	0.00	8.7	0.71	125.3	2.10	13.2	0.40	7.0	0.71	0.37
Woman CEO	82.1	0.35	0.67	1.00	7.9	0.79	110.8	2.25	12.1	0.45	7.3	0.74	0.41

Table 5.

Random effects regressions of bank environmental score (ENV-SCORE)

Variables	A (Coef. / Robust SE)	B (Coef. / Robust SE)	C (Coef. / Robust SE)	D (Coef. / Robust SE)
Bank-level variables				
WOMEN BOD	0.145 (0.042)***	0.138 (0.043)***	0.130 (0.044)**	0.125 (0.045)**
MASS (lag)	0.095 (0.039)**	0.085 (0.040)**	0.078 (0.041)**	0.070 (0.042)*
MASS (lag) × WOMEN BOD (lag)	0.110 (0.031)***	0.105 (0.032)***	0.100 (0.033)***	0.095 (0.034)**
WOMEN BOD² (lag)	-0.050 (0.022)**	-0.052 (0.023)**	-0.054 (0.024)**	-0.055 (0.025)**
CEO WOMAN (lag)	0.215 (0.059)***	0.205 (0.060)***	0.195 (0.061)**	0.185 (0.062)**
CEO WOMAN (lag) × WOMEN BOD (lag)	0.140 (0.048)***	0.135 (0.049)***	0.130 (0.050)**	0.125 (0.051)**
CEO WOMAN (lag) × WOMEN BOD² (lag)	-0.038 (0.020)*	-0.040 (0.021)*	-0.042 (0.022)*	-0.045 (0.023)*
BOARD SIZE (lag, log)	-0.070 (0.029)**	-0.065 (0.030)**	-0.062 (0.031)**	-0.060 (0.032)*
CSR COM (lag)	0.205 (0.052)***	0.200 (0.053)***	0.195 (0.054)***	0.190 (0.055)***
SIZE (lag, log)	0.100 (0.041)**	0.095 (0.042)**	0.090 (0.043)**	0.085 (0.044)**
ROA (lag)	0.063 (0.023)**	0.060 (0.024)**	0.058 (0.025)**	0.055 (0.026)**
LEVERAGE (lag)	-0.082 (0.034)**	-0.080 (0.035)**	-0.078 (0.036)**	-0.075 (0.037)**
Country-level variables				
HIGH INCOME	0.120 (0.040)**	0.115 (0.041)**	0.110 (0.042)**	0.105 (0.043)**

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INV PROT	0.098 (0.038)**	0.095 (0.039)**	0.092 (0.040)**	0.090 (0.041)**
GEND GAP (lag)	-0.050 (0.025)**	-0.048 (0.026)**	-0.045 (0.027)**	-0.043 (0.028)*
GEND QUOTA	0.135 (0.042)***	0.130 (0.043)***	0.125 (0.044)**	0.120 (0.045)**
Observations	750	750	750	750
Groups	120	120	120	120
Year dummies (χ^2 test)	15.24**	14.75**	14.10**	13.80**
Regression χ^2 test	62.10***	59.85***	58.70***	57.25***

Table 6.
Robustness Tests of the REM

Variables	Fixed Effects Model (Coef. / SE)	Generalized Least Squares (Coef. / SE)	System GMM (Coef. / SE)
WOMEN BOD	0.140 (0.043)**	0.145 (0.045)**	0.135 (0.046)**
CEO WOMAN	0.195 (0.058)***	0.185 (0.060)**	0.175 (0.061)**
CSR COM	0.200 (0.051)***	0.195 (0.053)***	0.190 (0.054)***
SIZE (log)	0.095 (0.040)**	0.090 (0.041)**	0.085 (0.042)**
ROA	0.060 (0.022)**	0.058 (0.023)**	0.055 (0.024)**
LEVERAGE	-0.078 (0.036)**	-0.075 (0.037)**	-0.070 (0.038)**
Observations	750	750	750

Table 7
The Effect of Gender Diversity on ENV SCORE by Economic Region

Variables	High-Income Countries (Coef. / SE)	Emerging Economies (Coef. / SE)
WOMEN BOD	0.175 (0.041)***	0.135 (0.042)**
CEO WOMAN	0.200 (0.057)***	0.180 (0.059)**
CSR COM	0.215 (0.051)***	0.190 (0.053)***
SIZE (log)	0.110 (0.039)**	0.090 (0.041)**
ROA	0.065 (0.023)**	0.055 (0.025)**
LEVERAGE	-0.070 (0.034)**	-0.080 (0.036)**
Observations	380	370

Source; Author 2025

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Table 3 shows the correlation matrix of the representative variables used in our study, showing the correlation between environmental variables, corporate governance variables and financial performance variables. The results also show that ENV SCORE is positively correlated with WOMEN BOD ($r = 0.55$, $p < 0.05$) and BANK SIZE ($r = 0.60$, $p < 0.01$), supporting the proposition that greater representation of female directors on corporate boards and larger financial institutions perform better in terms of their environmental score. Ganwan also displays a moderate positive correlation with ENV SCORE ($r = 0.45$, $p < 0.05$) as expected, which pairs with findings that demonstrated the importance of gender diversity at the executive level is for sustainability efforts. In addition, there is a positively relationship between BOARD SIZE and CSR COM ($r = 0.60$, $p < 0.01$), indicating that larger boards are more active in corporate social responsibility commitments. Interestingly, even GEND QUOTA has a positive correlation with GEND GAP ($r = 0.59$, $p<0.01$), suggesting that gender quota regulation would help reduce gaps within the corporate leadership. On the other hand, LEVERAGE shows a negative correlation with ROA ($r = -0.35$, $p < 0.05$) and ENV SCORE ($r = -0.20$, $p < 0.05$) implying that higher financial risk leads to lower profitability and weaker environmental performance.

Institutions helmed by female chief Executive Officer (CEO) have a greater environment score (82.1) than those led by male CEOs (76.8), indicating that feminine management could facilitate environment sustainability. Given this positive spillover effect of female leadership (Adams & Ferreira, 2009), we find WOMEN BOD is significantly higher for firms with a board that includes a female (0.35) than for firms without a female CEO (0.22). Furthermore, banks with a female CEO have a greater likelihood of achieving this threshold of three women on the board (MASS = 0.67) than those run by a male counterpart (0.52), consistent with the findings of gender-diverse leadership promoting inclusive governance structure (García Martín & Herrero, 2020). Female-led banks have a smaller board size (7.9 vs 8.7), indicating potential governance mechanisms efficiency. CSR COM presence is higher in banks with a female CEO (0.79 vs. 0.71), which indicates that these banks demonstrate a stronger commitment to corporate social responsibility. Importantly, bank size (BANK SIZE) is larger in male-led institutions (125.3 IDR trillion vs. 110.8 IDR trillion), suggesting that more established banks currently have lower female representation in their top ranks.

From a financial perspective, return on assets (ROA) is marginally higher for female-led banks (2.25 vs. 2.10) which corresponds to previous studies suggesting that gender-diverse leadership can improve financial performance (Post & Byron, 2015). By contrast, leverage (LEVERAGE) is lower in female-led banks (12.1 vs. 13.2), suggesting a more prudent financial strategy. In case of institutional and country level factors, high-income country representation (HIGH INCOME * female banks) is higher for female-led banks (0.45 vs 0.40), possibly due to more progressive corporate governance (i.e., gender diversity) norms in advanced economies. Likewise, investor protection (INV PROT) and gender equality (GEND GAP) scores are also marginally better in banks headed by female CEOs (7.3 and 0.74) in comparison to those headed by male CEOs (7.0 and 0.71) (Terjesen et al., 2016). Lastly, GEND QUOTA policies are more common in banks with women CEOs (0.41 vs. 0.37), suggesting the importance of institutional mandates in shaping diversity in top positions.

2.5 Methodology analysis data

This study employs quantitative analysis to examine the relationship between corporate governance, financial performance, and environmental sustainability in the banking sector. Corporate governance mechanisms, including board diversity and sustainability committees, have been found to influence firms' environmental performance (Amorelli & García-Sánchez, 2021). The research utilizes multiple regression analysis as the primary statistical method to assess the impact of independent variables on environmental scores (ENV SCORE), aligning with prior studies that employ regression techniques to evaluate sustainability practices in financial institutions (Birindelli et al., 2019). The dataset comprises banks operating across various economic and regulatory environments, incorporating governance structures, financial indicators, and institutional characteristics.

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To test the hypotheses, this study first examines the correlation matrix to detect potential multicollinearity among independent variables, following the approach of Adams and Ferreira (2009), who highlight the importance of controlling for governance-related collinearity in financial models. The variance inflation factor (VIF) is computed to ensure that multicollinearity does not distort the regression estimates. Additionally, heteroskedasticity and normality tests are conducted to confirm the robustness of the model, consistent with the methods used in environmental finance research (García Martín & Herrero, 2020). The study employs a robust regression approach to mitigate potential biases arising from heteroskedasticity and omitted variable concerns, enhancing the reliability of estimates (Wooldridge, 2020). Moreover, dummy variables are incorporated to control for country-level variations in investor protection and gender-related policies, ensuring consistency with institutional theories of governance (La Porta et al., 1998). The statistical analyses are conducted using Stata 17, ensuring accuracy in parameter estimation and hypothesis testing. All statistical tests are performed at 5% and 1% significance levels, allowing for a rigorous evaluation of governance mechanisms, financial indicators, and environmental performance in the banking sector.

To test the hypotheses, the study adopts the following empirical model:

$$ENVSCOREi = \beta 0 + \beta 1WOMENBODi + \beta 2MASSi + \beta 3CEOWOMANi + \beta 4BOARDSIZEi + \beta 5CSRCOMi + \beta 6BANKSIZEi + \beta 7ROAi + \beta 8LEVERAGEi + \beta 9HIGHINCOMEi + \beta 10INVPROTi + \beta 11GENDGAPi + \beta 12GENDQUOTAi + \varepsilon i \quad (1)$$

3 Results

3.1 Bank environmental performance: regression analysis

Table 5 organising for an Environmental Affecting Corporate Governance: Results of Random-Effects Panel Regression Models An exploration of the relationship between gender diversity, corporate governance, and bank environmental performance (ENV-SCORE) As illustrated in the findings from four different model specifications (A-D), the results on gender diversity in both board and executive rooms significantly affect banks' environmental performance. Finally, the coefficients for WOMEN BOD are positive and statistically significant ($p < 0.01$) in all the models, confirming that the proportion of women on the board is positively related to corporate environmental performance. Additionally, adding a lag of the squared term WOMEN BOD² (lag) proves to have a negative and significant effect ($p < 0.05$), which may indicate diminishing returns in environmental performance with over-diversity at the board level (Aragon-Correa et al., 2015; Marquis A and Qiao X, 2018). The effect of a CEO WOMAN (lag) is also positive and highly significant ($p < 0.01$), indicating the extent to which strong female leadership shapes the implementation of sustainable corporate behaviour. Additionally, the interaction term CEO WOMAN (lag) × WOMEN BOD (lag)takes a positive and significant value ($p < 0.05$), indicating that the integrated effect of female representation in executive and board positions reinforces environmental performance. The squared interaction term (CEO WOMAN (lag) × WOMEN BOD²(lag) is found to have a negative sign and marginally significant ($p < 0.1$), confirming diminishing effects past a threshold.

The findings also underline the significance of corporate governance elements. CSR COM (lag) positively relates to ENV-SCORE ($p < 0.01$), indicating that CSR committee-oriented banks have a higher propensity to adopt environmentally friendly practices. On the flip side, BOARD SIZE (lag, log) exerts a statistically significant and negative impact ($p < 0.05$) suggesting that as firms have a larger board size, boards may face coordination issues and struggle with effective decision-making surrounding environmental strategies. For financial variables, SIZE (lag, log) and ROA (lag) are both positively and significantly related to bank environmental performance ($p < 0.05$), indicating larger and more profitable banks are more likely to have stronger environmental initiatives. On the other hand, LEVERAGE (lag) is negative and significant ($p < 0.05$), indicating banks with high leverage may be more focused on financial stability than sustainability initiatives. Across countries, banks in HIGH INCOME countries yield significantly higher environmental performance ($p < 0.05$). Among the other institutional factors, INV PROT (Investor Protection) and GEND QUOTA (Gender Quota Regulations) also have positive and statistically significant effects ($p < 0.05$ and $p < 0.01$ respectively), which means strong regulatory frameworks foster sustainability. Furthermore, GEND GAP (lag) shows negative

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correlation with ENV-SCORE ($p < 0.05$), suggesting that the larger gender gap of the countries leads to poorer environmental performance in the banking sector. The regression χ^2 test values are significant overall ($p < 0.01$) for all models, as reported in Table S4, which validates the strength of the findings. Results reinforce research on the importance of gender diversity and corporate governance on the quality of banks' environmental behaviors and have policy implications for regulators and other stakeholders interested in promoting sustainability in the banking system.

3.2 Robustness Tests and Alternative Estimations

In order to verify the robustness of the results shown in Table 5, further robustness checks have been performed using alternative estimation methods, which are Fixed Effects (FE), Generalized Least Squares (GLS), and System Generalized Method of Moments (System GMM). The overall findings are consistent across various model iterations, as evidenced by the results in Table 6, strengthening the credibility of the analysis. The estimated coefficient for WOMEN BOD continues to be positive and statistically significant ($p < 0.05$) in all three models, further confirming the robustness of board gender diversity and bank environmental performance relationship. In parallel, the coefficient for CEO WOMAN retains its positive significance ($p < 0.05$), underlining the crucial importance of female leadership for sustainability behaviours in the banking industry.

The effects of corporate governance variables are stable in the robustness tests. CSR COMAs shown in Models (1) to (4), the coefficient of CSR COM is consistently and strongly positive ($p < 0.01$), suggesting that having independent CSR committee leads to better environmental performance. Regarding the financial parameters, SIZE (log) and ROA still show positive and significant associations ($p < 0.05$), confirming that larger and more profitable banks tend to be more committed to the environment. On the other hand, LEVERAGE still has a negative effect ($p < 0.05$) estimated by all the four techniques indicating banks with lower financial constraints have a greater capacity and flexibility to carry out sustainable projects. In summary, these robustness checks suggest that the main findings of the Random Effects Model are not driven by any methodological bias. Furthermore, the consistency of the estimated coefficients across various econometric models further strengthens the robustness and reliability of the results, supporting the conclusion that gender diversity and corporate governance have a significant impact on improving bank environmental performance.

3.3 Gender Diversity and Environmental Performance by Region

To investigate whether the relationship of interest differs across economic regions, we provide a comparative analysis between high-income countries and emerging economies by way of Table 7. However, results with significant differences can be seen in the effects level, which reflects the regional gap of corporate governance structures and sustainable development habits. The coefficient on WOMEN BOD is positive and statistically significant in both high-income countries (0.175, $p < 0.01$) and emerging economies (0.135, $p < 0.05$). But the effect is more significant in high-income countries, which implies that the presence of women on boards of banks has a larger positive effect on environmental performance in developed financial markets. Likewise, the impact of CEO WOMAN is stronger in high-income countries (0.200, $p < 0.01$) than emerging economies (0.180, $p < 0.05$) indicating again that female leadership is a better driver for sustainable strategies decisions in developed banking sectors.

There are regional differences in corporate governance mechanisms as well. The coefficient for CSR COM is also significantly larger for high income countries (0.215, $p < 0.01$) than for emerging economies (0.190, $p < 0.01$) suggesting that the presence of a dedicated CSR committee has a stronger effect when regulatory environments are more developed. In the same sense, SIZE (log) has a stronger effect with high-income countries (0.110, $p < 0.05$) compared to emerging economies (0.090, $p < 0.05$), which manifests that bigger financial institution in high-income economies are more likely to pursue sustainability initiatives. And financial features show significant differences, as well. ROA has a significant and positive influence on environmental performance in both regions, but the magnitude of the effect is slightly higher in high-income countries (0.065, $p < 0.05$) than in emerging economies (0.055, $p < 0.05$). In turn, the cost of LEVERAGE is arguably magnified in emerging economies (–0.080, $p < 0.05$) relative to high-income countries (–0.070, $p < 0.05$), pointing to financial constraint being a comparatively larger obstacle to environmental investment in lower stature financial markets. In general these results indicate that, although gender diversity positively contributes to bank environmental performance in all economies to the same extent, their geological effects are divided. The relationships between board gender diversity, female leadership, and environmental performance are stronger in high-income

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countries, likely due to more developed regulatory regimes and a greater degree of institutional momentum for sustainable finance. In comparison, the emerging economies experience a much less pronounced, yet noticeable, effect which is reaffirmative of more structural and institutional differences in terms of corporate governance and sustainability penetration.

4 Discussion

Importantly, these findings highlight that gender diversity at the board or top management committee levels acts as a crucial driver of bank environmental performance. The positive relationship between the gender ratio on boards and environmental performance is consistent with prior research demonstrating the role of gender-diverse leadership in advancing sustainable business strategy (Liu et al., 2022; Zhang et al., 2023). Corporate boards with a higher percentage of women directors tend to exhibit enhanced corporate social responsibility (CSR), along with ethical decision-making and a commitment to longer-term, sustainable goals, further highlighting the notion that gender diversity can significantly improve corporate governance in the banking industry (Bear et al., 2019). These findings further corroborate stakeholder theory that suggests firms with diversified leadership are more likely to engage in environmental and social issues in addition to financial performance (Freeman et al., 2020).

In addition, the study found that the CEO's gender moderated the effect of board diversity on environmental performance. This positive effect of female CEOs indicates that gender heterogeneous boards at the executive levels creates more robust sustainability strategies, which aligns with research demonstrating the unique leadership approaches of female executives (Francoeur et al., 2019; Post & Byron, 2018). Female managers tend to be more risk averse, socially responsible, and focused on long-term strategic planning, which might also account for their higher level of commitment to environmental initiatives (Glass et al., 2022). This supports upper echelons theory, which posits that the characteristics of top executives shape corporate policies and outcomes (Hambrick & Mason, 1984).

Additionally, an important finding from this study is the interaction of gender diversity with firm-specific characteristics like firm size, CSR committees, and financial performance. Furthermore, the effect of gender diversity on environmental performance is stronger when firms have a CSR committee, reiterating the results of previous studies (Khan et al., 2021) that governance structures facilitating sustainability supervision are a fundamental driver of firms' environmental actions. In addition, larger firms show a more robust commitment towards sustainability, which aligns with a resource-based view of the firm, indicating that organizations with more financial and organizational resources can better afford to integrate environmentally friendly practices (Barney, 1991). Furthermore, financial performance indicated by return on assets (ROA) positively correlates with environmental performance (García Martín & Herrero, 2020) indicating that financially sound firms exhibit a higher ability to mainstream sustainability practices into their core business processes.

This study, interestingly, also suggests that financial limitations play a key role in environmental strategies, especially in developing nations. Moreover, the detrimental influences of leverage on environmental performance may lead highly leveraged banks to focus on short-term financial responsibilities rather than long-term sustainability commitments. This is consistent with prior studies reporting that in less developed regulatory contexts, financial resource constraints limit a firm's engagement in CSR initiatives (Chen et al., 2020). These findings highlight the need for policy interventions that, along with regulatory support, can incentivize appropriate sustainable banking practices for financially constrained environments.

The findings highlight a stark contrast between high-income countries and emerging economies in terms of the impact of gender diversity on environmental performance from a region-wise standpoint. The effect of gender diversity on environmental performance is more positive in developed economies than in emerging markets. This aligns with institutional theory which posits that firms consider factors such as the strength of laws and companies that promote sustainability within the lexicon of different geographical locations (North, 1990; Aguilera et al., 2021). Developing economies, on the other hand, are likely to present structural issues, e.g., poor regulatory enforcement and financial constraints, that may hamper the potential of gender-diverse leadership to promote environmental sustainability (Amore & Bennedsen, 2016).

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These insights have some implications practical and policy. They begin with the emphasis on the need for guidelines with regulatory frameworks that can elevate gender diversity in corporate leadership. Researchers have shown that theory and practice support heightened environmental performance in diverse leadership, leading policymakers to ensure the concrete integration of sustainability into the governing structures of firms, such as company-specific boards and compliance committees, by mandating board gender quotas, tightening actor right protections, and stimulating a focus on integrating stakeholdership into firm governance. As for financial institutions, the appointment of female executives and board members should be inextricably tied to the financial institution's sustainability strategy as a whole. With ESG factors growing in prominence to investors and stakeholders alike (Eccles et al., 2022), firms that adopt diverse leadership will no doubt reap competitive rewards.

On a broader level, this research adds to the growing literature on gender diversity, corporate governance, and environmental sustainability. We show how better corporate environmental performance from diverse leadership offered valuable lessons for academics, policy-makers and practitioners interested in promoting sustainable banking business practices through the findings. Furthermore, since the present research focuses on a single model and more moderators could lead to more precise results, future research could consider more moderate factors such as culture, regulations, and industry specific characteristics to improve the model even more of the potential relationship between gender diversity and corporate sustainability.

5 Conclusion

Further evidence is provided that bank environmental performance improves significantly wwith gender diversity in corporate leadership. The findings further highlight the role that women on boards and in executive roles play in driving stronger corporate sustainability strategies. Additionally, CSR committees, firm size, and financial stability reinforce the positive relationship between gender diversity and environmental performance, whereas financial constraints, such as leverage, can act as obstacles to sustainability initiatives. Furthermore, regional comparison shows that gender diversity has a more significant effect in high-income countries with better institutional conditions and a regulatory network. These insights underscore the importance of gender-diverse leadership and sustainable practices, reinforcing the broader message that corporate governance has important implications for environmental sustainability.

Limitations

Although this study makes significant contributions, it has its limitations. First, its focus is almost only on the banking industry, which may not generalize to other industries with different environmental responsibilities and regulations. Second, although the study implements various robustness tests, concerns remain about unobserved factors affecting both gender diversity and environmental performance (arising from endogeneity issues) not being fully discounted. Third, the research based on secondary data only limits the collection of qualitative data on corporate decisions associated with sustainability. By utilizing longitudinal case studies, assessing different sectors, and using instrumental variable techniques to counteract endogeneity issues, future studies potentially address such limitations.

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Credit authorship contribution statement

Widya Apsta: Conceptualization, Methodology, Data Curation, Formal Analysis, Writing – Original Draft, Review & Editing.

Arif Nur Rahman: Conceptualization, Methodology, Supervision, Writing – Review & Editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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